USER MANUAL

NI SMD-7613/7614/7615/7616

This manual contains information about the configuration and use of the National Instruments SMD-7613, SMD-7614, SMD-7615, and SMD-7616. They are referred to inclusively in this manual as the NI SMD-761x.

Note This manual is not applicable for NI SMD-7610/7611/7612 devices. Refer to to the unique documentation for information related to the NI SMD-7610/7611/7612.

Functionality on these devices are roughly equivalent. The NI SMD-7613/7615 operates from 18 to 53 VDC, and has a running current of up to 5 A per phase. The SMD-7614/7616 operates from 18 to 88 VDC, and runs current up to 10 A per phase. The SMD-7615/7616 features encoder feedback.

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Safety Information

Only qualified personnel are permitted to transport, assemble, commission, and maintain this equipment. Properly qualified personnel are persons who are familiar with the transport, assembly, installation, commissioning and operation of motors, and who have the appropriate qualifications for their jobs. The qualified personnel must know and observe the following standards and regulations:

- IEC 364 resp. CENELEC HD 384 or DIN VDE 0100
- IEC report 664 or DIN VDE 0110
- National regulations for safety and accident prevention or VBG 4

To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and it is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes.

Equipment damage or serious injury to personnel can result from the failure to follow all applicable codes and standards. We do not guarantee the products described in this publication are suitable for your particular application, nor do we assume any responsibility for your product design, installation, or operation.

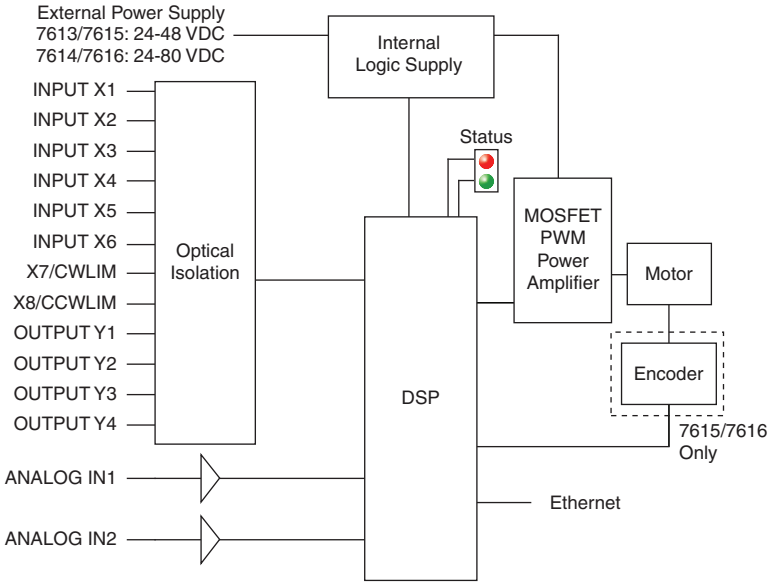
- Read all available documentation before assembly and commissioning. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information on the installation requirements.
- It is vital to ensure that all system components are connected to earth ground. Electrical safety is impossible without a low-resistance earth connection.
- The SMD-761x contains electrostatically sensitive components that can be damaged by incorrect handling. Discharge yourself before touching the product. Avoid contact with high insulating materials (artificial fabrics, plastic film, etc.). Place the product on a conductive surface.
- During operation keep all covers and cabinet doors shut. Otherwise, there are deadly hazards that could possibility cause severe damage to health or the product.
- In operation, depending on the degree of enclosure protection, the product can have bare components that are live or have hot surfaces. Control and power cables can carry a high voltage even when the motor is not rotating.
- Never pull out or plug in the product while the system is live. There is a danger of electric arcing and danger to persons and contacts.

- After powering down the product, wait at least ten minutes before touching live sections of the equipment or undoing connections (e.g., contacts, screwed connections). Capacitors can store dangerous voltages for long periods of time after power has been switched off. To be safe, measure the contact points with a meter before touching.

Be alert to the potential for personal injury. Follow the recommended precautions and safe operating practices. Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. The purpose of this section is to alert users to possible safety hazards associated with this equipment and the precautions that need to be taken to reduce the risk of personal injury and damage to the equipment. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.

Block Diagram

Figure 1. NI SMD-761x Block Diagram



Getting Started

You need the following to use your NI SMD-761x stepper drive:

☐ a 24 to 48 VDC power supply (80 V max for NI SMD-7614/7616). Refer to *Choosing a Power Supply* for help in choosing the right power supply

☐ one of the recommended motors

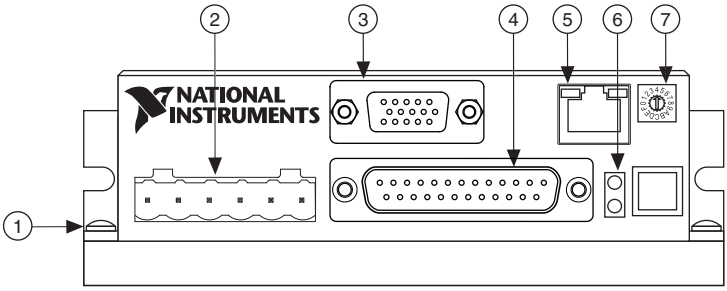
☐ a small flat blade screwdriver for tightening the connectors

☐ a source of step signals, such as a PLC or motion controller

The connectors and other points of interest are illustrated below. These are detailed later in the manual.

Figure 2 shows an overview of the connectors on the NI SMD-7613/7614/7615/7616 stepper drive.

Figure 2. NI SMD-7613/7614/7615/7616 Stepper Drive Connectors



1 Chassis Grounding Screw
2 Motor and Power Supply Connector
3 Encoder Feedback (SMD-7615/7616)
4 Input and Output Signals
5 Ethernet Connector
6 Drive Status LEDs
7 Rotary Switch

Mounting the Drive

You can mount your drive on the wide or the narrow side of the chassis using #6 screws. If possible, the drive should be securely fastened to a smooth, flat metal surface that will help conduct heat away from the chassis. If this is not possible, then forced airflow from a fan may be required to prevent the drive from overheating. Refer to *Drive Heating* for more information.

- Never use your drive in a space where there is no air flow or where other devices cause the surrounding air to be more than 50 °C.
- Never put the drive where it can get wet or where metal or other electrically conductive particles can get on the circuitry.
- Always provide air flow around the drive. When mounting multiple drives near each other, maintain at least one half inch of space between drives.

Connecting the Power Supply

If you need information about choosing a power supply, refer to *Choosing a Power Supply*.

- Connect the power supply “+” terminal to the connector terminal labeled “V+”.
- Connect power supply “-” to the connector terminal labeled “V-”.
- The green ground screw on the corner of the chassis should be connected to earth ground.
- Use 18 or 20 gauge wire.

The NI SMD-761x drives contain an internal fuse that connects to the power supply + terminal. This fuse is not user replaceable. If you want to install a user serviceable fuse in your system, install a fast acting, 7 A fuse in line with the + power supply lead.

Caution Do not reverse the wires. Reverse connection will destroy your drive and void your warranty.

If you plan to use a regulated power supply you may encounter a problem with regeneration. If you rapidly decelerate a load from a high speed, much of the kinetic energy of that load is transferred back to the power supply. This can trip the overvoltage protection of a switching power supply, causing it to shut down. NI offers the SMD-7700 regeneration clamp to solve this problem. If in doubt, buy an SMD-7700 for your first installation. If the regen LED on the SMD-7700 never flashes, you don't need the clamp.

Choosing a Power Supply

When choosing a power supply, there are many things to consider. If you are manufacturing equipment that will be sold to others, you probably want a supply with all the safety agency approvals. If size and weight are an issue, get a switching supply.

And you must decide what size of power supply (in terms of voltage and current) is needed for your application.

National Instruments offers two power supplies that are excellent matches for the NI SMD-761x drives: PS-12 24V, 6.3A) and PS-13 (48V, 6.7A).

Voltage

The motor can provide more torque at higher speeds if a higher power supply voltage is used. Refer to the *Torque Speed Curves* section for guidance.

If you choose an unregulated power supply, make sure the no load voltage of the supply does not exceed the drive's maximum input voltage specification.

Current

The maximum supply current you could ever need is two times the motor current. However, you will generally need a lot less than that, depending on the motor type, voltage, speed and load conditions. That's because the NI SMD-761x uses a switching amplifier, converting a high voltage and low current into lower voltage and higher current. The more the power supply voltage exceeds the motor voltage, the less current you'll need from the power supply. A motor running from a 48 volt supply can be expected to draw only half the supply current that it would with a 24 volt supply.

We recommend the following selection procedure:

1. If you plan to use only a few drives, get a power supply with at least twice per phase current rating of the step motor. Example: for a motor that's rated for 2 A/phase use a 4 A power supply.

2. If you are designing for mass production and must minimize cost, get one power supply with more than twice the rated current of the motor. Install the motor in the application and monitor the current coming out of the power supply and into the drive at various motor loads. This will tell you how much current you really need so you can design in a lower cost power supply.

Tables 1 lists the relevant specifications for suggested motors. Please consider this information when choosing a power supply.

Table 1. NI SMD-7613/7615 Power Supply Current

Motor	Holding Torque		Drive Current Setting (A)	Resistance (Ω)	Inductance (mH)	Rotor Inertia (g-cm^2)
	oz-in	kg-cm				
ST11-1	7.0	0.50	1.2	1.4	1.4	8
ST11-2	15.0	1.08	1.2	2.0	2.6	18
ST14-1	26.0	1.87	1.2	4.3	5.5	20
ST17-1	31.4	2.26	1.6	2.1	2.8	35
ST17-2	51.0	3.67	2.0	1.7	3.6	54
ST17-3	62.8	4.52	2.0	1.7	3.0	68
ST23-1	76.6	5.52	3.4	0.7	1.4	120
ST23-4	177	12.7	5.0	0.4	1.2	300
ST23-6	264	19.0	5.0	0.5	1.6	480
ST23-8	354	25.48	6.0	0.5	2.2	750
ST24-1	123.2	8.87	3.36	0.73	1.6	260
ST24-2	177	12.74	4.8	0.43	1.1	450
ST24-3	354	24.48	4.8	0.65	2.4	900
ST34-2	650	46.8	10.0	0.19	1.3	1400
ST34-5	1200	86.4	9.7	0.27	2.2	2680
ST34-8	1845	133	10.0	0.27	2.4	4000
ST34-1	396.5	28.55	7.56	0.24	1.7	1100
ST34-4	849.6	61.18	7.56	0.33	2.7	1850
ST34-7	1260	90.75	6.72	0.63	5.4	2750

Regeneration

When a motor rapidly decelerates from high speed under load, the kinetic energy may be reconverted into electrical energy and transferred back to the power supply. When using regulated power supplies, this can trip the overvoltage protection and lead to a shutdown, or cause damage to the system. Unregulated power supplies do not typically have overvoltage protection, and may store regenerated energy in capacitors.

Connecting the Drive Using Ethernet

The drive requires only a CAT5 Ethernet cable connection to connect to your PC. You can connect the drive directly to your PC's network card, to an auxiliary network card in your PC, or to a router or network switch.

1. Physically connect the device to your network (or directly to the PC).
2. Set the drive IP address.
3. Set the appropriate networking properties on your PC.

Your device includes a 16 position rotary switch for setting its IP address. The factory default address for each switch setting is shown in the table below.

Table 2. IP Address Rotary Switch Settings

Position	IP Address	
0	10.10.10.10	
1	192.168.1.10	
2	192.168.1.20	
3	192.168.1.30	
4	192.168.0.40	
5	192.168.0.50	
6	192.168.0.60	
7	192.168.0.70	
8	192.168.0.80	
9	192.168.0.90	
A	192.168.0.100	
B	192.168.0.110	
C	192.168.0.120	
D	192.168.0.130	
E	192.168.0.140	
F	DHCP	

The IP address corresponding to positions 1 through E can be changed using the NI Stepper Configuration Utility software. Setting 0 is always 10.10.10.10, the universal recovery address.

Setting F is DHCP, which commands the device to get an IP address from a DHCP server on the network. The IP address automatically assigned by the DHCP server may be dynamic or static depending on how the administrator has configured DHCP. The DHCP setting is reserved for advanced users.

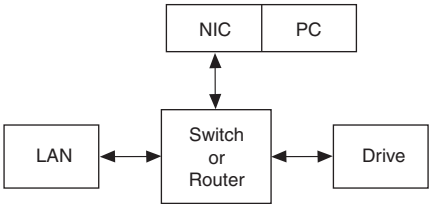
Your PC, or any other equipment that you use to communicate with the device, will also have a unique address.

On the device switch settings 1 through E use the standard class B subnet mask (i.e., 255.255.0.0). The mask for the universal recovery address is the standard class A (i.e., 255.0.0.0).

Option 1: Connect a Drive to Your LAN

If you have a spare port on a switch or router and if you are able to set your device to an IP address that is compatible with your network, and not used by anything else, this is a simple way to get connected. This technique also allows you to connect multiple devices to your PC. If you are on a corporate network, check with your system administrator before connecting anything new to the network. He or she should be able assign you a suitable address and help you get going.

Figure 3. Example Network Configuration



Many networks use dynamic addressing where a DHCP server assigns addresses on demand. The address you choose for your device might get assigned to something else by the DHCP server at another time.

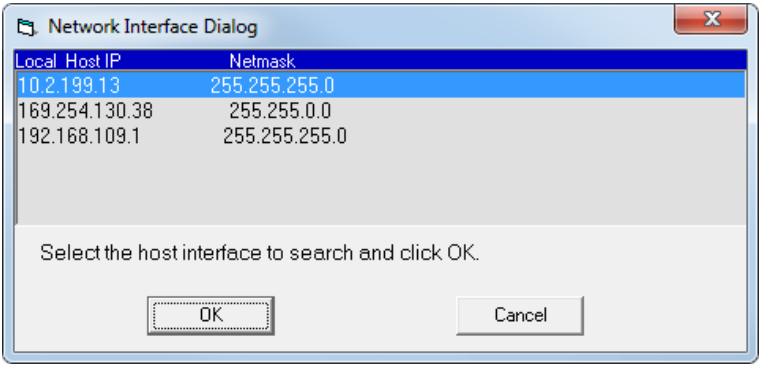
Once you've chosen an appropriate IP address for your device, set the rotary switch according to the address table above. If none of the default addresses are acceptable for your network, you can enter a new table of IP addresses using the NI Stepper Configuration Utility. If your network uses addresses starting with `192.168.0`, the most common subnet, you will want to choose an address from switch settings 4 through E. Another common subnet is `192.168.1`. If your network uses addresses in this range, the compatible default selections are 1, 2 and 3. If your PC address is not in one of the above private subnets, you will have to change your subnet mask to `255.255.0.0` in order to communicate with your device. To change your subnet mask:

1. Open **Network Connections**.
   a. **Windows 8.1/8/7/Vista**—Open **Control Panel**. From the icon view, open **Network and Sharing Center**, then click **Change Adapter Settings**.
   b. **Windows XP**—Right-click **My Network Places** and select **Properties**.
2. Right-click your network interface card (NIC) and select **Properties**.
   a. **Windows 8.1/8/7/Vista**—Scroll down and select **(TCP/IPv4)**, then click **Properties**.
   b. **Windows XP**—Scroll down and select **Internet Properties (TCP/IP)**, then click **Properties**.
3. If the **Obtain an IP address automatically** option is selected, your PC is getting an IP address and a subnet mask from the DHCP server. Cancel this dialog and proceed to the *Using DHCP* section.
4. If the option **Use the following IP address** is selected, change the subnet mask to `255.255.0.0` and click **OK**.

Using DHCP

If you want to use your device on a network where all or most of the devices use dynamic IP addresses supplied by a DHCP server, set the rotary switch to "F". When the device is connected to the network and powered on, it will obtain an IP address and a subnet mask from the server that is compatible with your PC. However, you will not know what address the server assigns to the device. The NI Stepper Configuration Utility can find your device using the **Drive Discovery** feature, as long as your network isn't too large. When the device connected to the network is powered on, select **Drive Discovery** from the **Drive** menu to launch the **Network Interface Dialog** dialog box.

Figure 4. Network Interface Dialog Box



Normally, Drive Discovery only detects one network interface card (NIC), and selects it automatically. If you are using a laptop and have both wireless and wired network connections, a second NIC may appear. Please select the NIC that you use to connect to the network to which you've connected your device. Then click **OK**. Drive Discovery notifies you as soon as it has detected a device.

If you think this is the correct device, click **Yes**. If you are not sure, click **Not Sure** and Drive Discovery will look for additional devices on you network. Once you have told Drive Discovery which device is yours, it automatically enters the device IP address in the IP address text box so that you are ready to communicate.

Option 2: Connect a device Directly to Your PC

1. Connect one end of a CAT5 Ethernet cable into the LAN card (NIC) on your PC and the other into the device. You don't need a special crossover cable; the device automatically detects the direct connection and make the necessary physical layer changes.
2. Set the IP address on the device to `10.10.10.10` by setting the rotary switch to position 0.
3. To set the IP address of your PC:
   a. **Windows 8.1/8/7/Vista**—Open **Control Panel**. From the icon view, open **Network and Sharing Center**, then click **Change Adapter Settings**.
   b. **Windows XP**—Right-click **My Network Places** and select **Properties**.

4. Right-click your network interface card (NIC) and select **Properties**.
   a. **Windows 8.1/8/7/Vista**—Scroll down and select **(TCP/IPv4)**, then click **Properties**.
   b. **Windows XP**—Scroll down and select **Internet Properties (TCP/IP)**, then click **Properties**.
5. Select **Use the following IP address** and enter the address `10.10.10.11`. This assigns your PC an IP address that is on the same subnet as the device. Windows directs any traffic intended for the device's IP address to this interface card.
6. Next, enter the subnet mask as `255.255.255.0`.
7. Leave **Default gateway** blank. This prevents your PC from looking for a router on this subnet.

Note Because you are connected directly to the device, anytime the device is not powered you will receive a small message bubble in the corner of your screen saying "The network cable is unplugged."

Option 3: Use Two Network Interface Cards (NICs)

This technique allows you to keep your PC connected to your LAN, but keeps the device off the LAN, preventing possible IP conflicts or excessive traffic.

1. If you use a desktop PC and have a spare card slot, install a second NIC and connect it directly to the device using a CAT5 cable. You don't need a special "crossover cable"; the device will automatically detect the direct connection and make the necessary physical layer changes.
2. If you use a laptop and only connect to your LAN using wireless networking, you can use the built-in RJ45 Ethernet connection as your second NIC.
3. Set the IP address on the device to `10.10.10.10` by setting the rotary switch to position 0.
4. To set the IP address of your PC:
   a. **Windows 8.1/8/7/Vista**—Open **Control Panel**. From the icon view, open **Network and Sharing Center**, then click **Change Adapter Settings**.
   b. **Windows XP**—Right-click **My Network Places** and select **Properties**.
5. Right-click your network interface card (NIC) and select **Properties**.
   a. **Windows 8.1/8/7/Vista**—Scroll down and select **(TCP/IPv4)**, then click **Properties**.
   b. **Windows XP**—Scroll down and select **Internet Properties (TCP/IP)**, then click **Properties**.
6. Select **Use the following IP address** and enter the address `10.10.10.11`. This assigns your PC an IP address that is on the same subnet as the device. Windows directs any traffic intended for the device's IP address to this interface card.
7. Next, enter the subnet mask as `255.255.255.0`.
8. Leave **Default gateway** blank. This prevents your PC from looking for a router on this subnet.

Note Because you are connected directly to the device, anytime the device is not powered you will receive a small message bubble in the corner of your screen saying "The network cable is unplugged."

Motor Wiring Recommendations

This section explains how to connect motors to the NI SMD-761x. Refer to your motor documentation for any special considerations that may affect your configuration.

Maintain at least 2 in. separation between the power supply cable and input lines or encoder feedback. All power supply cables should be properly shielded, and the shield grounded at the power supply. Signal cables should be shielded, and grounded as close as possible to the signal source.

Caution Never connect or disconnect the motor while the system is powered on.

Note Ensure any shield or grounding strap on the motor is connected to the chassis ground screw located near the motor/power connector.

Figure 5. Motor/Power Connector

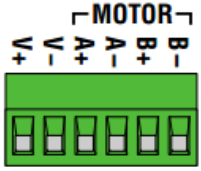


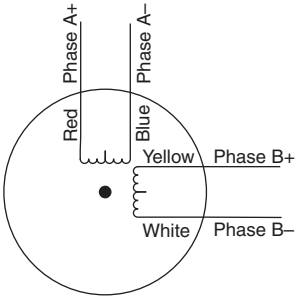
Figure 6. Grounding Screw on the Chassis

Four Lead Motors

Four lead motors can only be configured according to the following diagram.

Note Motor wire colors are correct for NI stepper motors compatible with the NI SMD-761x. These wire colors may not match a third-party stepper motor.

Figure 7. Four Lead Motor Connection



Six Lead Motors

Six lead motors can be connected in series or center tap. A series connected motor produces more torque but it will not be able to run as fast as a motor in center tap configuration. In series operation, the motor should be operated at 30% less than the rated current to prevent overheating. Refer to the wiring diagrams below to connect a six lead motor.

Figure 8. Six Lead Motor Connected in Series

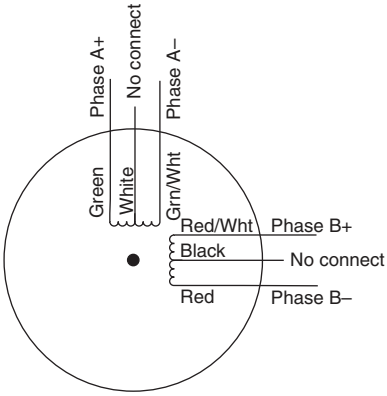
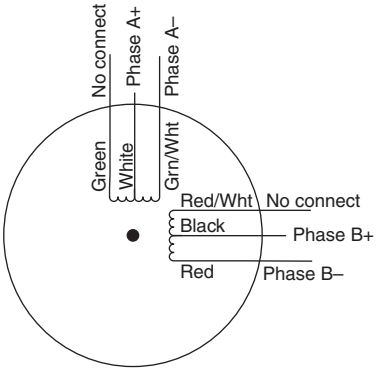


Figure 9. Six Lead Motor Connected in Center Tap



Eight Lead Motors

Eight lead motors can be connected in series or parallel. A series connected motor needs less current than one that is connected in parallel but it will not be able to run as fast. In series operation, the motor should be operated at 30% less than the rated current to prevent overheating. Refer to the wiring diagrams below to connect an eight lead motor.

Figure 10. Eight Lead Motor Connected in Series

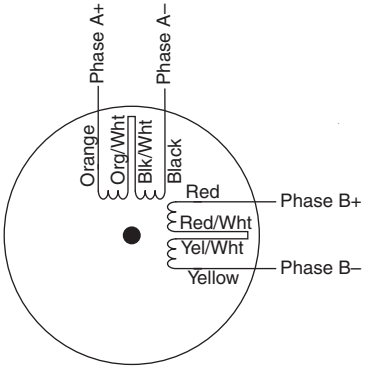
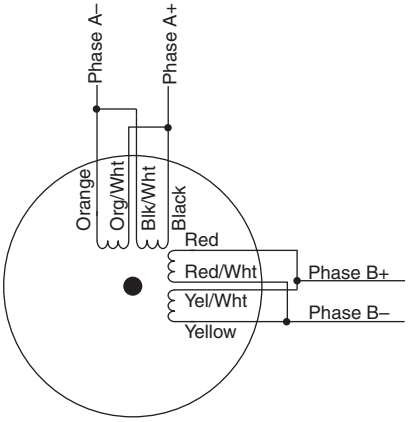


Figure 11. Eight Lead Motor Connected in Parallel



Connecting Input Signals

The NI SMD-761x has three types of input:

- High speed digital inputs for step and direction commands/encoder following. 5 V logic.
- Digital inputs for other signals. 12 to 24 V logic.
- Analog inputs are reserved for furture use.

Note All inputs except STEP and DIR use 12 to 24 VDC logic.

All drives include eight digital inputs and two analog inputs:

- CW & CCW Limit: Optional input that can be used to inhibit motion in a given direction, forcing the motor and load to travel within mechanical limits. It can be configured for active closed or active open.
- IN1/STEP & IN2/DIR: Digital signals that can be used for commanding position. Quadrature signals from encoders can also be used. These inputs can also be connected to sensors and switches.
- IN3, IN4, IN5, IN6: Software-prgrammable inputs that can be used for motor enable, alarm reset, or jogging. These inputs can also be connected to sensors and switches.
- Analog In: Analog signals that can command velocity or position. Can be configured for 0 to 10 V, 0 to 5 V, ±10 V, or ±5 V, with or without an offset.

Figure 12. Input Connector Pin Diagram

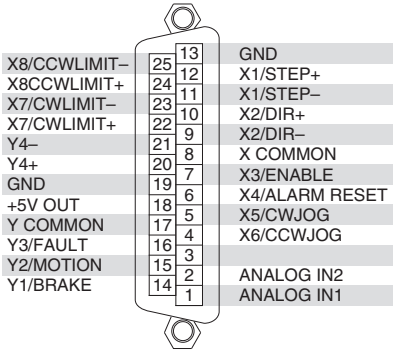
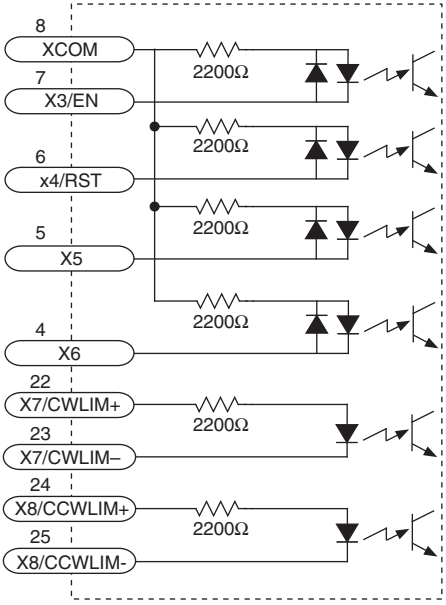


Figure 13. ISelect Internal Circuitry of the I/O Connector



STEP and DIR Inputs

The drive includes two high speed inputs called STEP and DIR. They accept 5 volt single-ended or differential signals, up to 2 MHz. Normally these inputs connect to an external controller that provides step & direction command signals. You can also connect a master encoder to the inputs for following applications. The following section demonstrates example signal connections. Refer to *Motor Wiring Recommendations* for cable instructions.

Figure 14. Connecting to Indexer with Sourcing Outputs

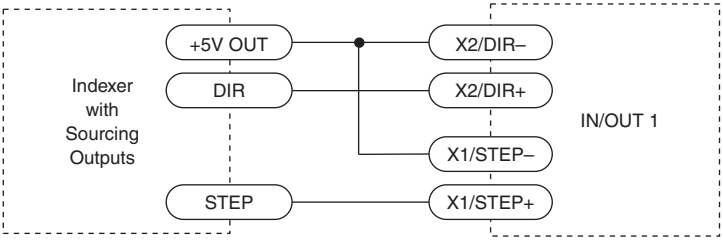


Figure 15. Connecting to Indexer with Sinking Outputs

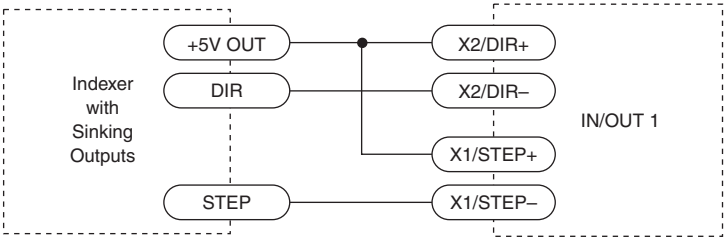


Figure 16. Connecting to Indexer with Differential Outputs

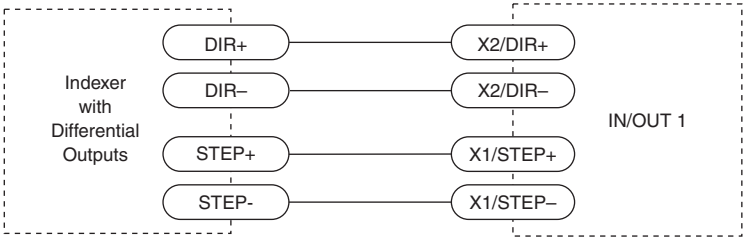
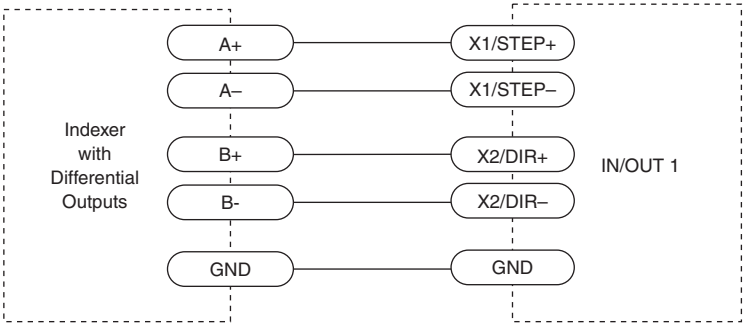


Figure 17. Connecting for Encoder Following



Using 12 to 24 Volt Signals

Most PLC's don't use 5 V signals. Use external dropping resistors to connect signals up to 24 V to the STEP and DIR inputs. For 12 V logic, use 820 Ω, 1/4 W resistors. For 24 V logic, use 2200 Ω, 1/4 W resistors.

Caution Do not exceed an input voltage of 24 VDC. Never apply AC power to an input terminal.

Connect the resistors according to the following diagrams:

Figure 18. Connecting to PLC with Sourcing (PNP) Outputs

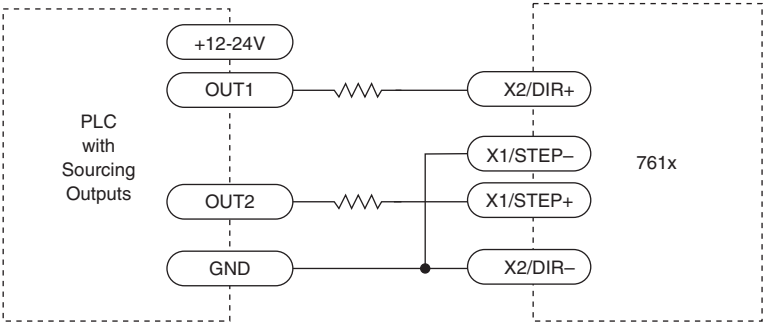


Figure 19. Connecting to PLC with Sinking (NPN) Outputs

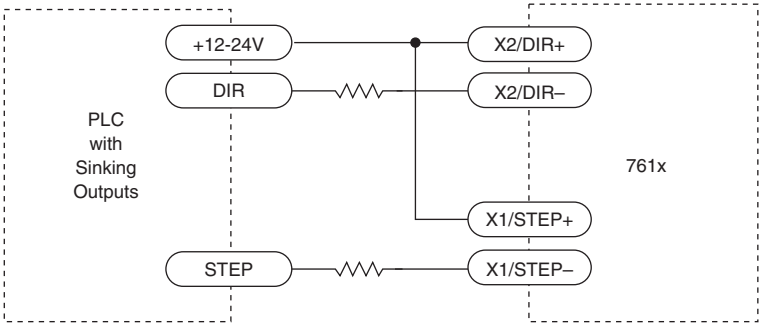
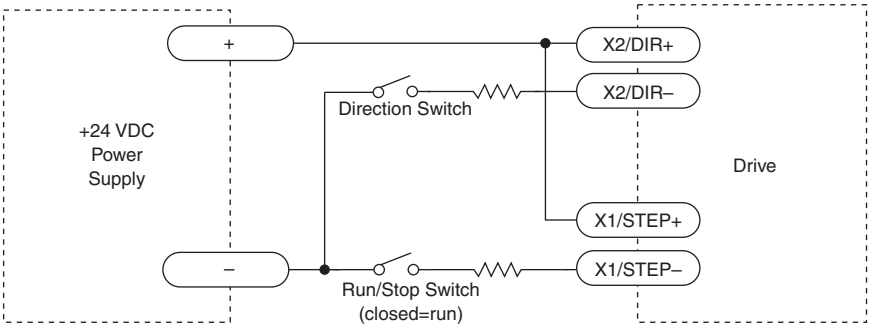


Figure 20. Using Mechanical Switches at 24 Volts



Single Ended Inputs

The SMD-761x includes four single ended, optically isolated input circuits that can be used with sourcing or sinking signals. These inputs can be used with PLCs, sensors, relays, or mechanical switches. These inputs require an external power supply.

Note COM, or common, refers to a connection to a common voltage. This is often ground, but not always.If using sourcing (PNP) signals, connect COM to the negative terminal of the power supply. When using sinking (NPN) signals, connect COM to the positive terminal of the power supply.

Refer to the following diagrams for examples of how to connect the drive to commonly used devices:

Figure 21. Connecting to Input Switch or Relay

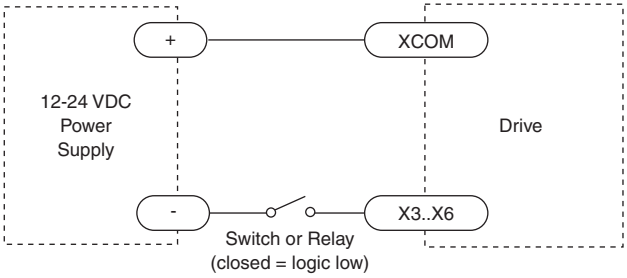


Figure 22. Connecting Multiple Drives

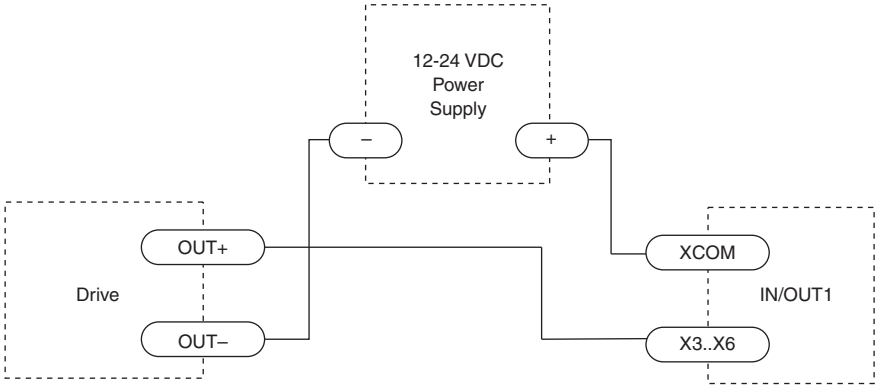


Figure 23. Connecting an NPN Type Proximity Sensor to an Input

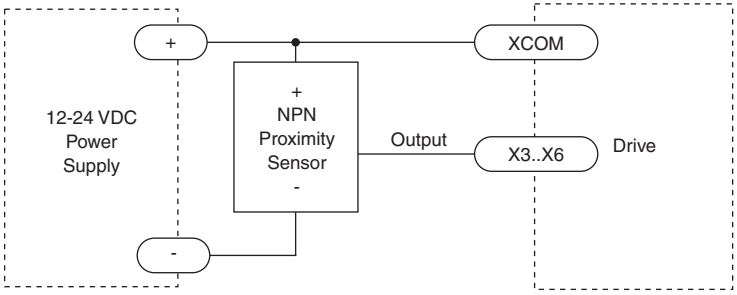
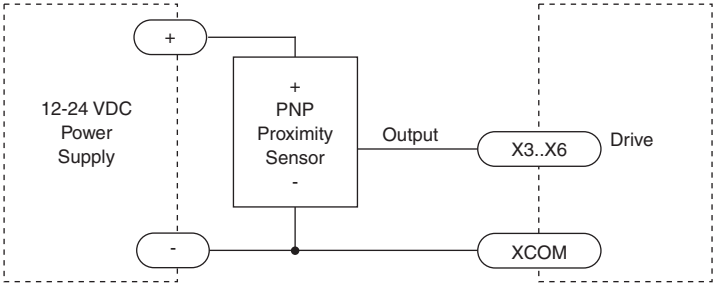


Figure 24. Connecting a PNP Type Proximity Sensor to an Input



Connecting Limit Switches and Sensors

The CWLIMIT and CCWLIMIT differential inputs can be used to connect end of travel sensors. You can use signals that are sinking (NPN), sourcing (PNP) or differential (line driver). By connecting switches or sensors that are triggered by the motion of the motor or load, you can force the motor to operate within certain limits, preventing damage to your system by traveling too far.

The limit inputs are optically isolated, allowing you to choose a voltage for your limit circuits of 12 to 24 VDC. This also allows you to have long wires on limit sensors that may be far from the drive with less risk of introducing noise to the drive electronics.

Refer to the following diagrams for help connecting limit switches and sensors:

Figure 25. Wiring a Mechanical Limit Switch

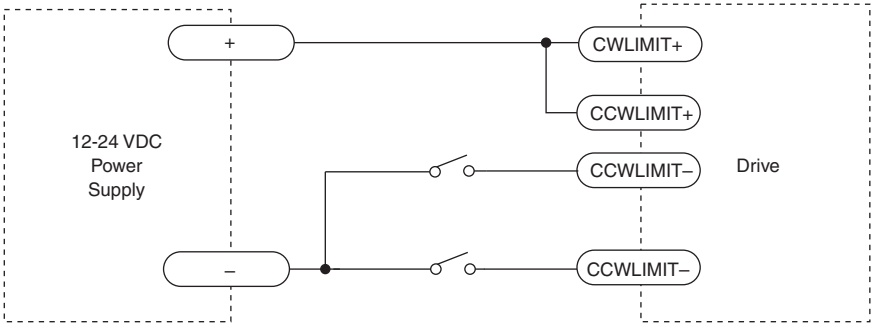


Figure 26. Wiring a Sinking Output Limit Sensor

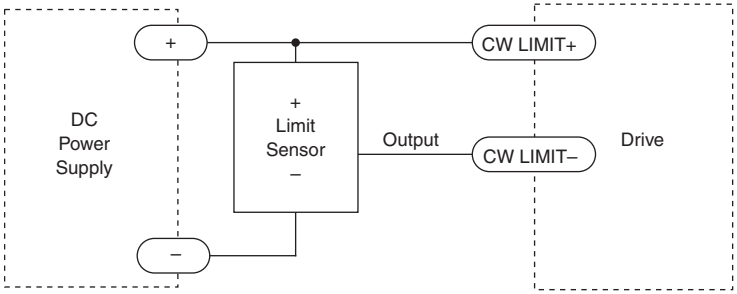
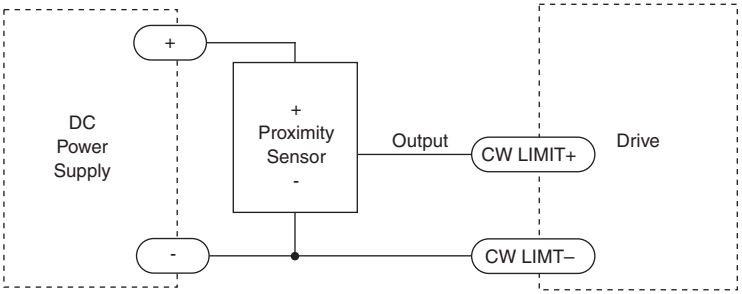


Figure 27. Wiring a Sourcing Output Proximity Sensor

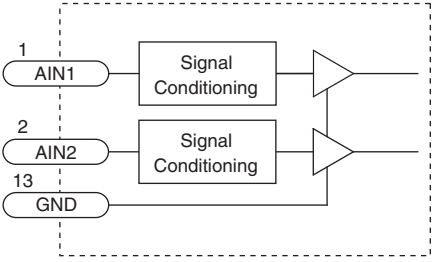


Analog Inputs

The device features two analog inputs. Each input can accept a signal range of 0-VDC, ±5 VDC, 0 to 10 VDC or ±10 VDC. The drive can be configured to operate at a speed or position that is proportional to the analog signal.

The following figure represents the internal circuitry of the analog inputs:

Figure 28. Internal Circuitry of Analog Inputs

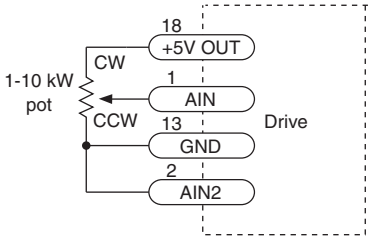


Caution Always use a shielded cable to maintain signal integrity.

Us the NI Stepper Configuration Utility to configure settins such as signal range, offset, deadband, and filter frequency.

The following diagram depicts the connection of a potentiometer to the analog input, which could be used to control the commanded position or velocity.

Figure 29. Potentiometer Connected to Analog Input 1



Connecting an Encoder (SMD-7615/7616)

The encoder connections use a HD-15 connector, which you must connect to your encoder as shown below.

If your encoder is single ended, connect the encoder outputs to the A+, B+ and Z+ inputs. Leave A-, B- and Z- unconnected. (Z is the encoder index signal and is optional.)

Figure 30. Encoder Connection Pin Numbering

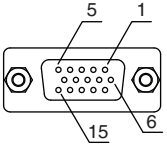


Table 3. Encoder Connection Pin Definition

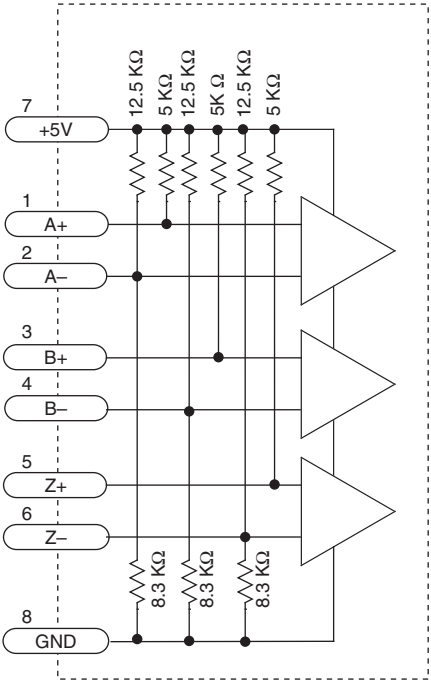
Pin	Function
1	Encoder A+
2	Encoder A-
3	Encoder B+
4	Encoder B-
5	Encoder Z+
6	Encoder Z-
7	+5 VDC, 200 mA

Table 3. Encoder Connection Pin Definition (Continued)

Pin	Function
8	GND
9	No Connect
10	No Connect
11	No Connect
12	No Connect
13	No Connect
14	No Connect
15	Shield

The internal circuitry of the encoder connection is depicted below:

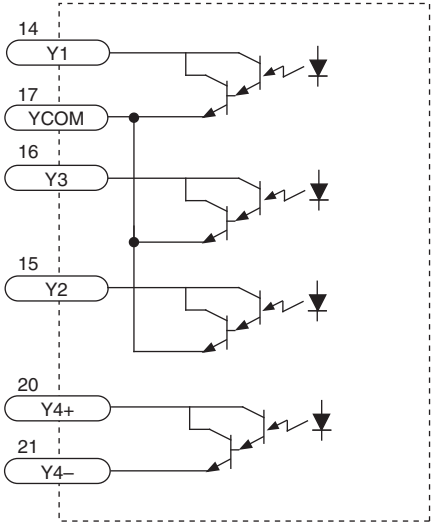
Figure 31. Encoder Connection Pin Numbering



Programmable Outputs

The drive features four digital outputs. These outputs can be set to automically control a motor brake, to signal a fault condition, to indicate when the motor is moving, or to provide an output frequency proportional to motor speed (tach signal). Refer to the diagram below for a representation of the internal cirtucitry of the digital outputs:

Figure 32. Potentiometer Connected to Analog Input 1



The outputs can be used to drive LEDs, relays, and the inputs of other electronic devices like PLCs and counters. For Y4, the "+" (collector) and "-" (emitter) terminals of each transistor are available at the connector. This allows you to configure this output for current sourcing or sinking. The Y1 to 3 outputs can only sink current. The Y COM terminal must be tied to power supply (-).

Diagrams of each type of connection follow.

Caution Do not connect outputs to more than 30 VDC.

Caution The current through an output terminal must not exceed 100 mA.

Figure 33. Sinking Output Using Y1, Y2, or Y3

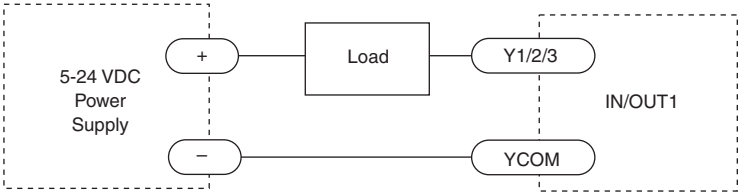


Figure 34. Sinking Output Using Y4

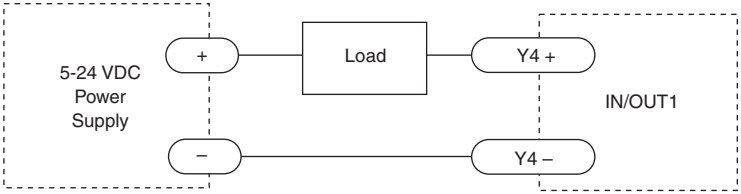


Figure 35. Sourcing Output Using Y1, Y2, or Y3

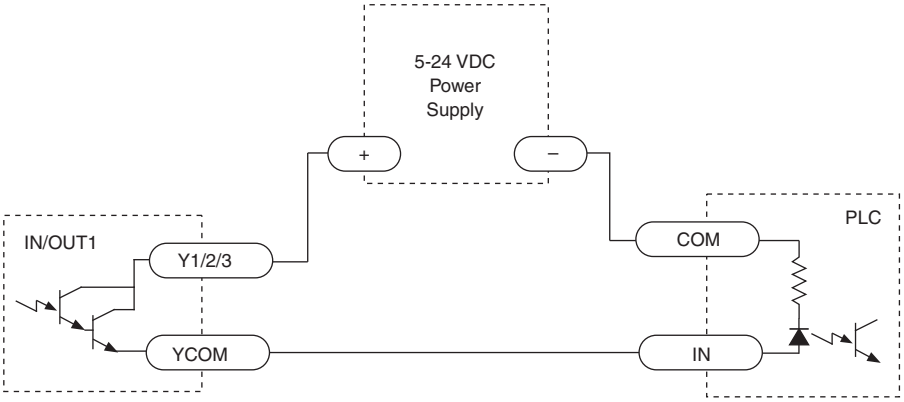


Figure 36. Sourcing Output Using Y4

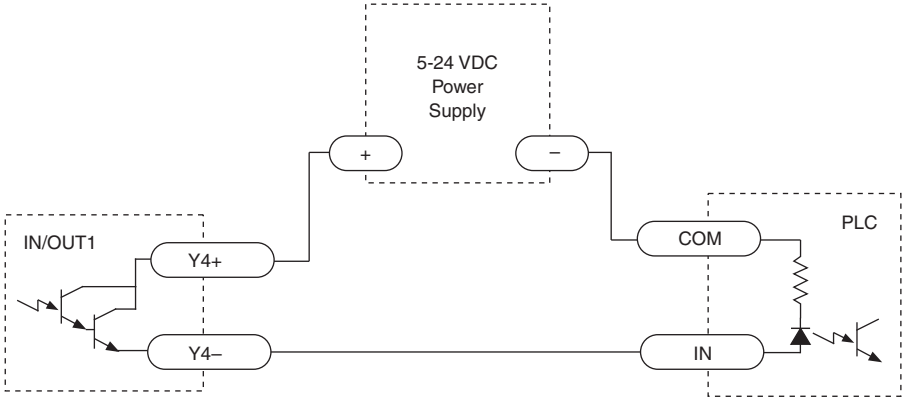


Figure 37. Driving a Relay Using Y1, Y2, or Y3

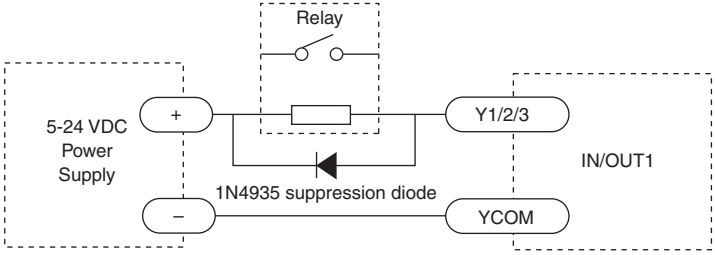
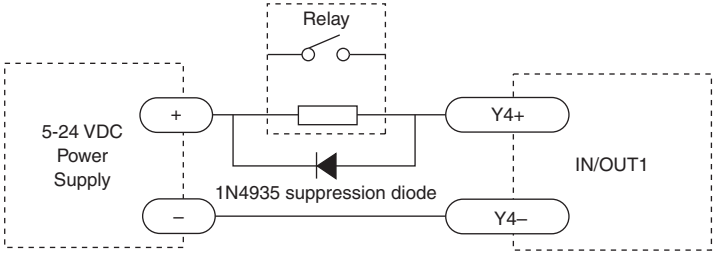


Figure 38. Driving a Relay Using Y4



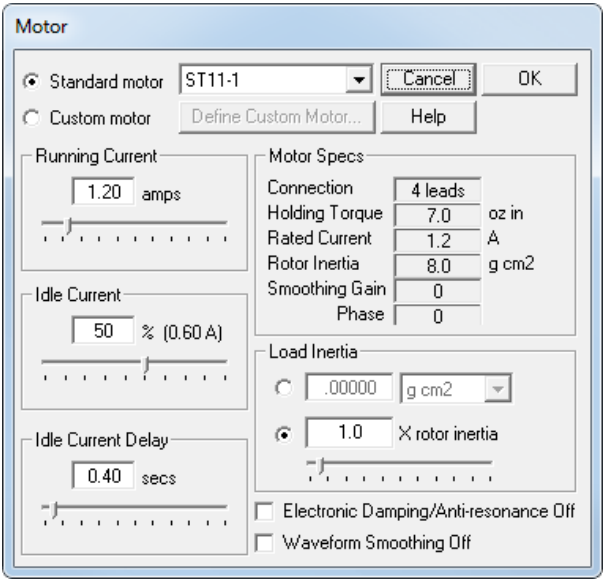
Configuring the Drive

The drive is configured in software with the NI Stepper Configuration Utility, available at `ni.com/downloads`. When you have located your device with the utility, you can configure various aspects of the motor performance and control for your application.

Motor

From the NI Stepper Configuration Utility home screen, click the **Motor** icon to open the configuration window.

Figure 39. NI Stepper Configuration Utility Configuration Window



The drive works best with the specially matched motors selectable from the Standard Motor list. Select the motor you will use and configure the following settings:

Running Current

Seting the Running Current to 100% will achieve maximum torque. However, under some conditions you might want to reduce the current to save power or lower motor temperature. This is important if the motor is not mounted to a surface that will help it conduct heat away or if you expect the ambient temperature to be high.

Step motors produce torque in direct proportion to current, but the amount of heat generated is roughly proportional to the square of the current. If you operate the motor at 90% of rated current, the motor provides 90% of the rated torque and approximately 81% as much heat. At 70% current, the torque is reduced to 70% and the heating to about 50%.

Idle Current/Idle Current Delay

You can reduce motor heating and power consumption by lowering the motor current when it is not moving. The drive automatically lowers the motor current when it is idle for longer than the time specified by Idle Current Delay.

The default 50% idle current setting lowers the holding torque to 50% of the specified Running Current, which is enough to prevent the load from moving in most applications. You can adjust this value to account for your load and heating requirements.

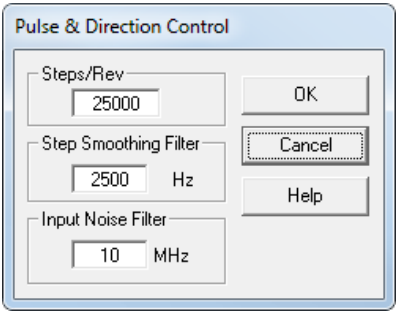
Load Inertia

The drive includes anti-resonance and electronic damping features which greatly improve motor performance. To perform optimally, the drive must understand the electromechanical characteristics of the motor and load. Most of this is completed automatically in the factory during motor and drive assembly. To further enhance performance, you must specify the innertia of the load. If you are unsure of this value, you can experimentally find an acceptable value by entering a multiplier of the rotor inertia.

Control

From the NI Stepper Configuration Utility home screen, click the **Motion** icon to open the Motion Control Mode Window. Select the **Pulse & Direction Mode** button to configure the following settings:

Figure 40. NI Stepper Configuration Utility Configuration Window



Steps/Rev

You can configure the number of steps per revolution to match the details of your application. A higher value provides smoother motion, though you may want to configure this value to match the phsyical parameters of the system such as gearing or screw pitch.

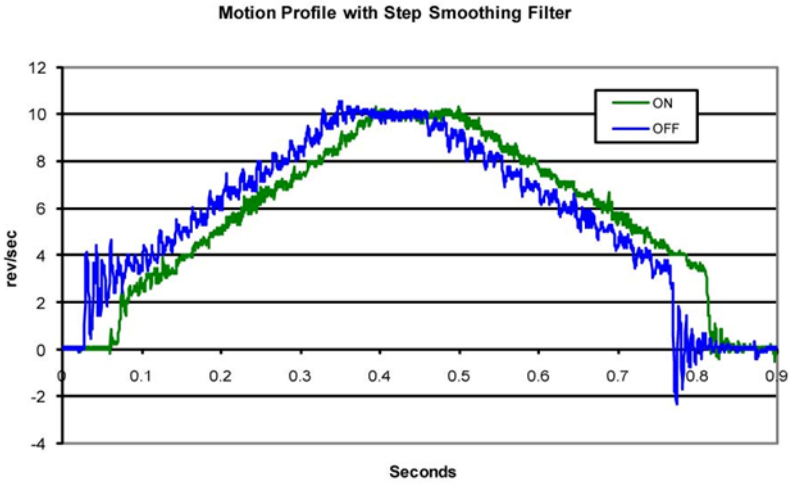
Step Smoothing Filter

At lower step resolutions such as 200 steps per revolution (full step) and 400 steps per revolution (half step) motors produce more audible noise than when they are microstepped (2000 steps per revolution and beyond). The drive includes a feature called microstep emulation, also called step smoothing, that can provide smooth motion when using full and half steps. If the Steps/Rev

setting is 2000 or higher, this feature is not needed and can be set to the highest possible value, 2500.

The step smoothing process uses a command filter which causes a slight delay, or lag in the motion. The following figure shows an example of the delay that can occur from using the step smoothing filter.

Figure 41. Delay Due to Filtering



Input Noise Filter

Electrical noise can negatively affect the STEP signal by causing the drive to interpret one step pulse as two or more pulses. This results in extra motion and inaccurate motor and load positioning. To solve this problem, the drive includes a digital noise filter on the STEP and DIR inputs. The default factory setting of this filter is 7.5 MHz, which is suitable for most applications.

Your maximum pulse rate equals the highest motor speed multiplied by the number of steps per revolution. For example:

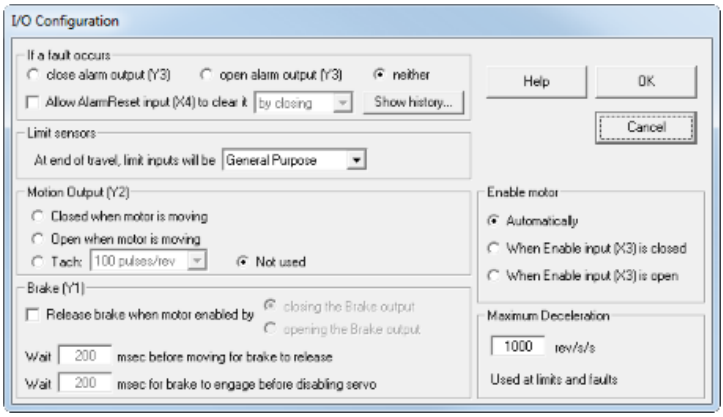
$$40\frac{revs}{second} \times 20,000\frac{steps}{revs} = 800kHz$$

Consider the maximum pulse rate when deciding whether you must increase the filter frequency.

I/O Configuration

From the NI Stepper Configuration Utility home screen, click the **I/O** icon to open the Motion I/O Configuration window to configure the following settings:

Figure 42. NI Stepper Configuration Utility Configuration Window



Fault Output

The fault output will be triggered if there is a fault condition. This may be a fault within the drive or a system fault. Not all faults will cause the drive to be disabled. If you are running the NI Stepper Configuration Utility while an alarm condition develops, a dialog box will give you details of the fault. Alarms and faults are also displayed by a pattern of red and green flashes on the drive's front panel LED. Refer to the Alarm Code section for code definitions.

Alarm Reset Input

This parameter allows you to configure an input to reset any alarms that result from a fault. If this is not enabled, you must reset alarms by cycling power to the drive.

Brake Output

If your motor features a brake, you can configure an output to release the brake when the motor is enabled. You can configure the delay settings to ensure the brake is fully applied before disabling the motor.

Motor Enable Input

The Motor Enable input toggles the power stage of the drive. This allows the drive to be powered on while the motor is inactive.

Self Test

If you are having trouble getting your motor to turn, use the built-in self test from the NI Stepper Configuration Utility home page. Select the **Drive** menu item and choose **Self Test**. Use this feature to confirm that the motor is wired correctly, selected, and otherwise operational.

Figure 43. SMD-761x Torque Curve for ST11 & ST14, 24 V Power Supply

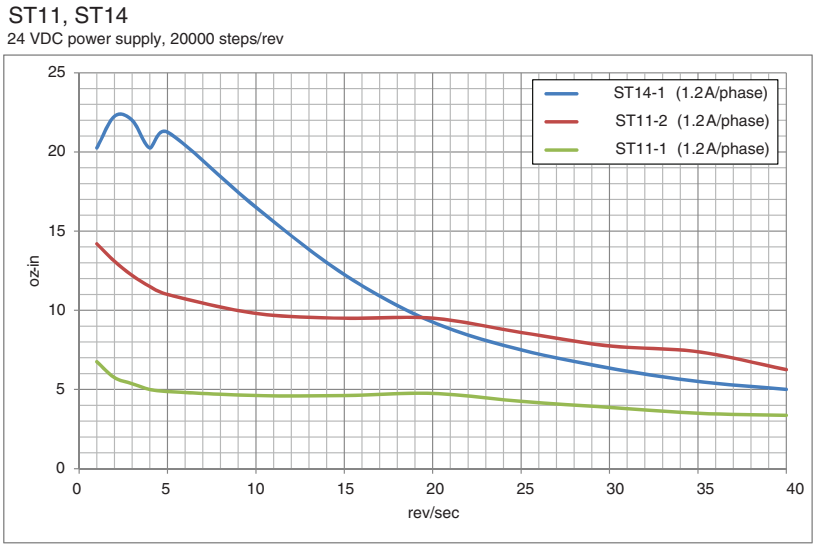


Figure 44. SMD-761x Torque Curve for ST17, 24 V Power Supply

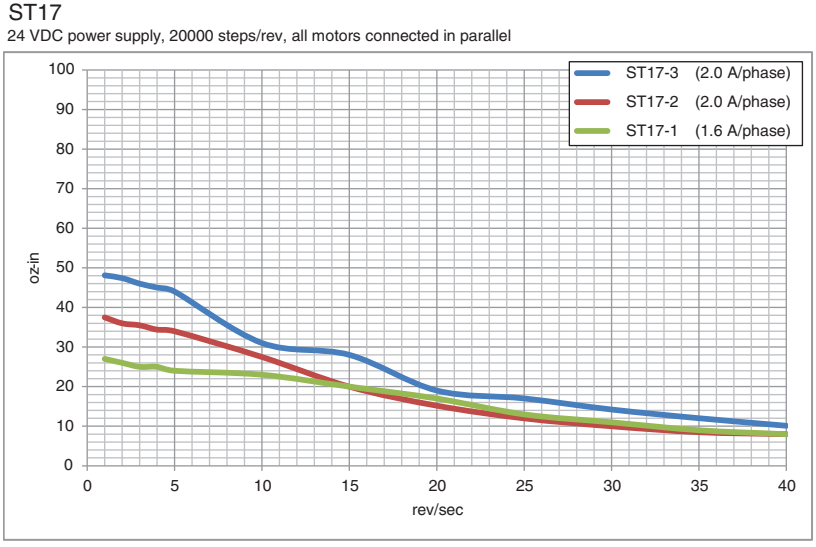


Figure 45. SMD-761x Torque Curve for ST17, 48 V Power Supply

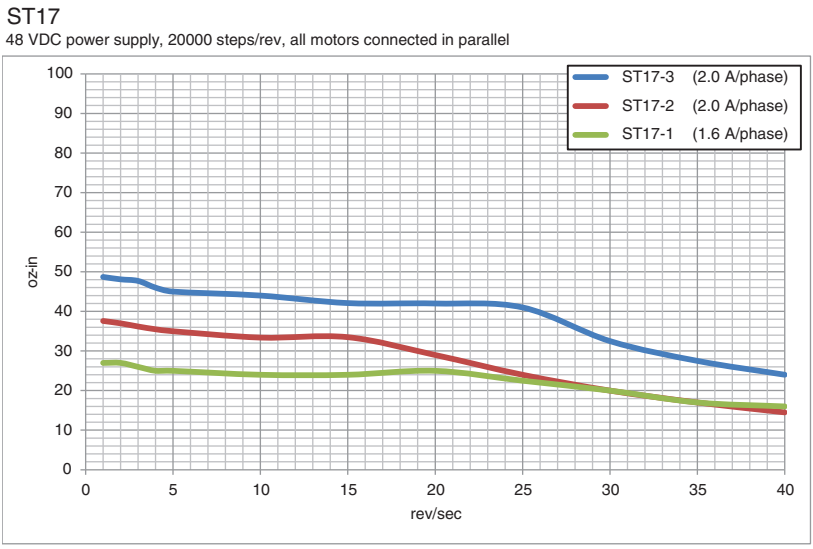


Figure 46. SMD-761x Torque Curve for ST23, 24V Power Supply

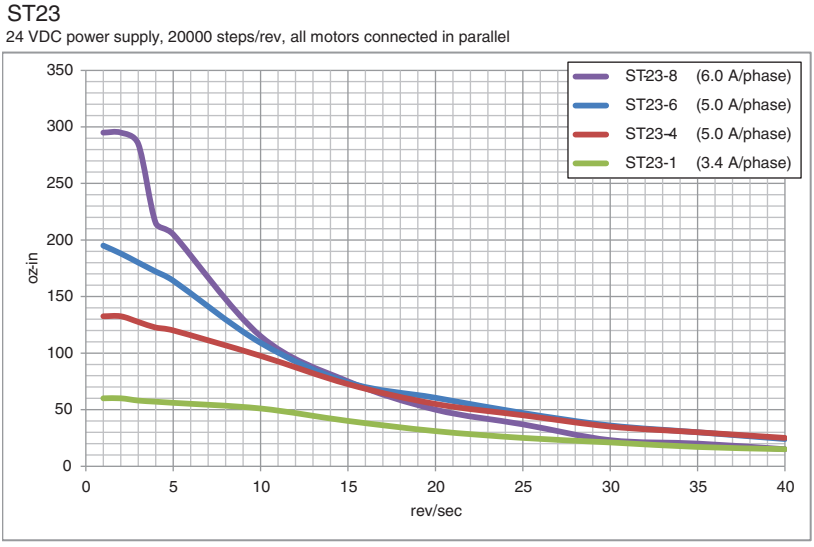


Figure 47. SMD-761x Torque Curve for ST23, 48 V Power Supply

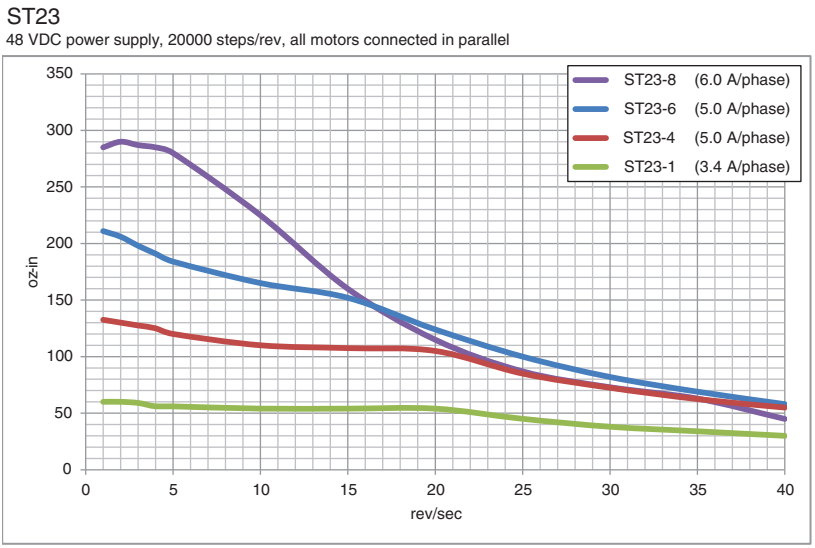


Figure 48. SMD-761x Torque Curve for ST24, 24V Power Supply

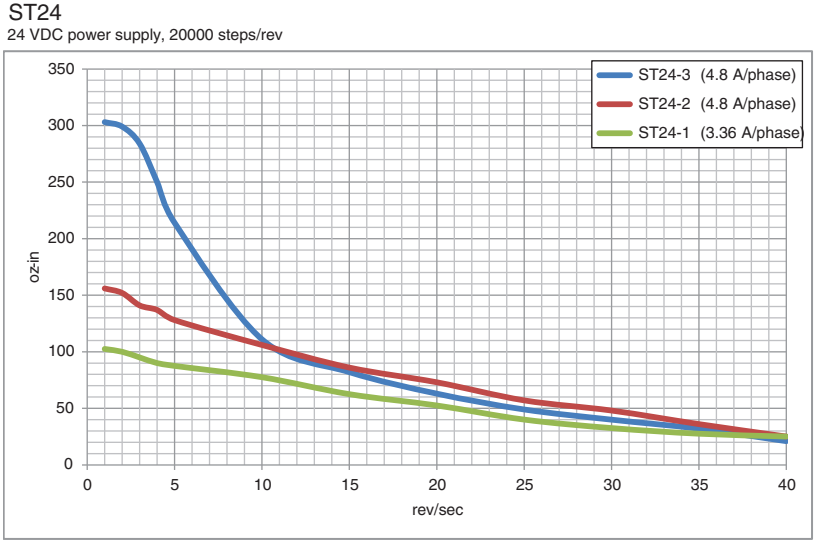


Figure 49. SMD-761x Torque Curve for ST24, 48V Power Supply

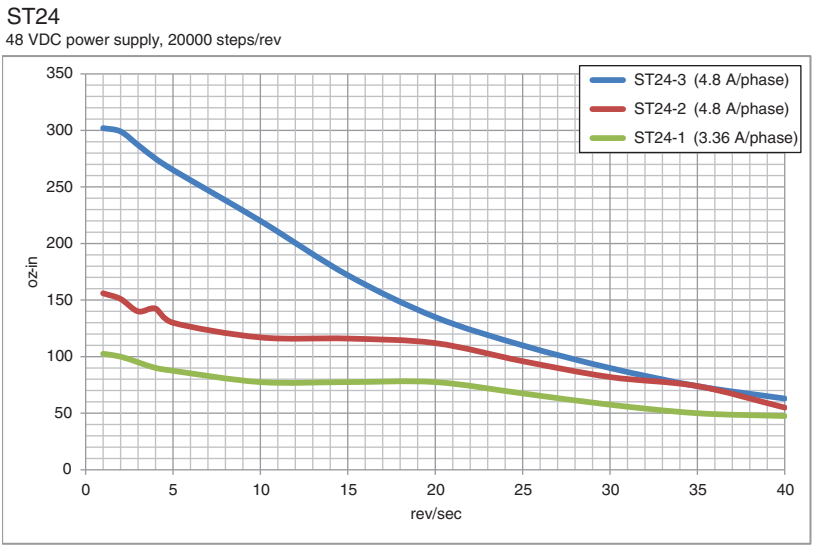


Figure 50. SMD-7614/7616 Torque Curve for ST34-2/5/8, 48V Power Supply

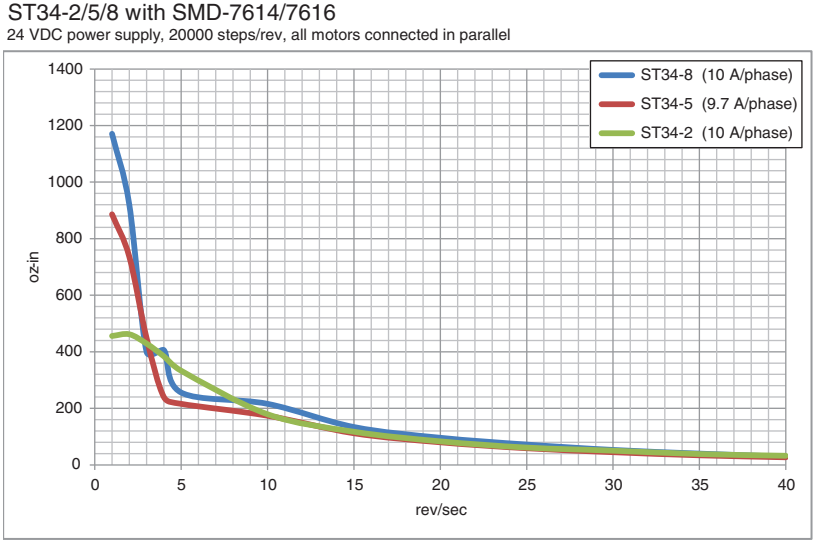


Figure 51. SMD-7614/7616 Torque Curve for ST34-2/5/8, 48V Power Supply

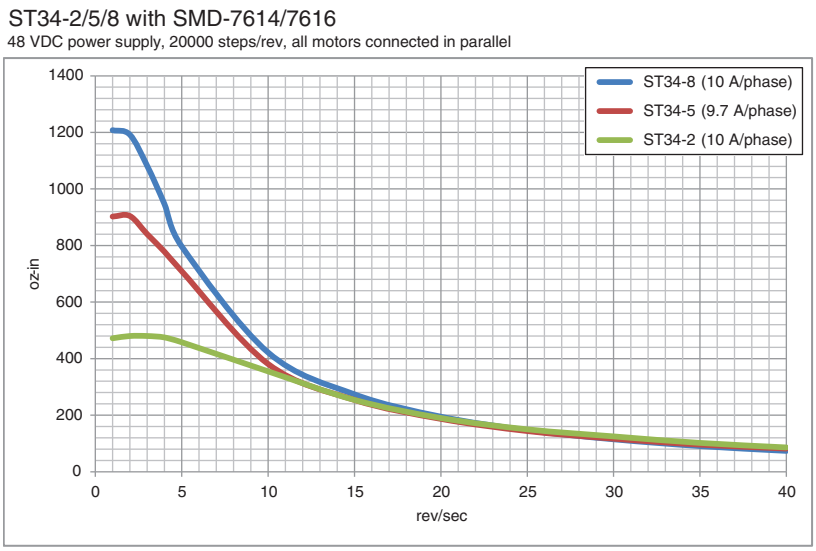


Figure 52. SMD-7614/7616 Torque Curve for ST34-2/5/8, 80V Power Supply

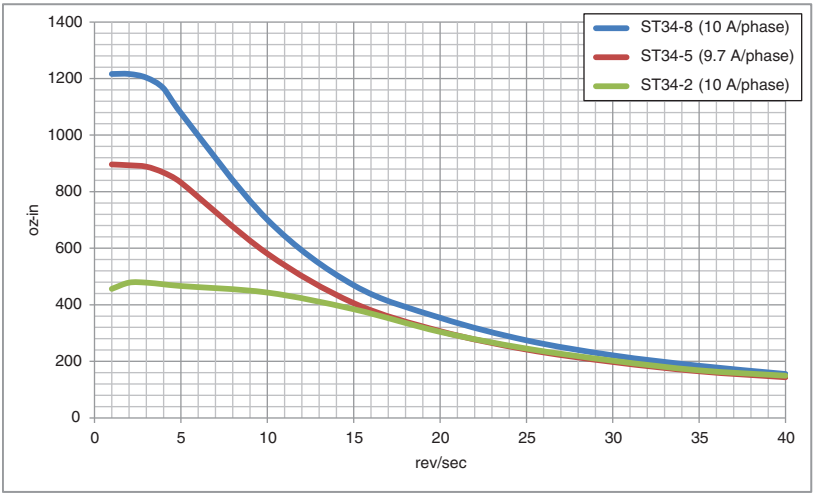


Figure 53. SMD-7614/7616 Torque Curve for ST34-1/4/7, 24V Power Supply

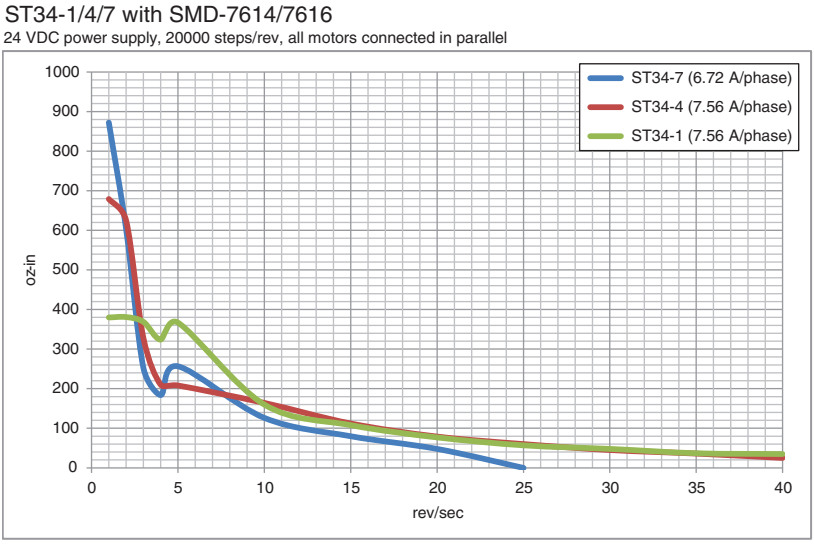


Figure 54. SMD-7614/7616 Torque Curve for ST34-1/4/7, 48V Power Supply

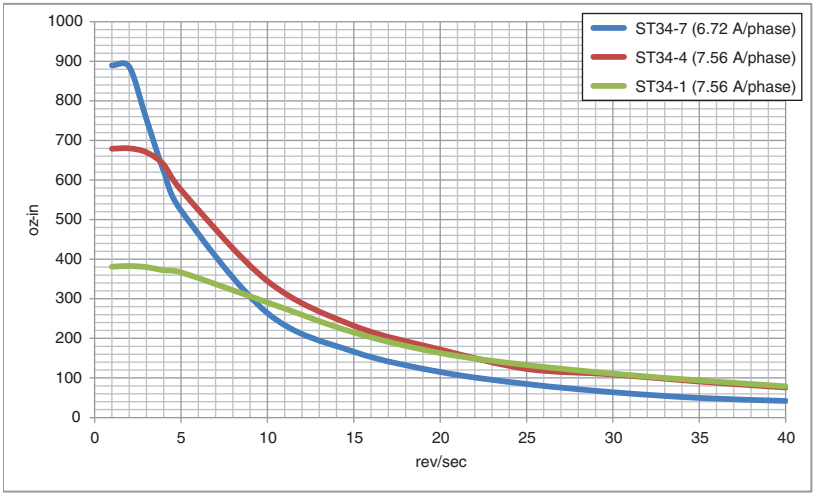
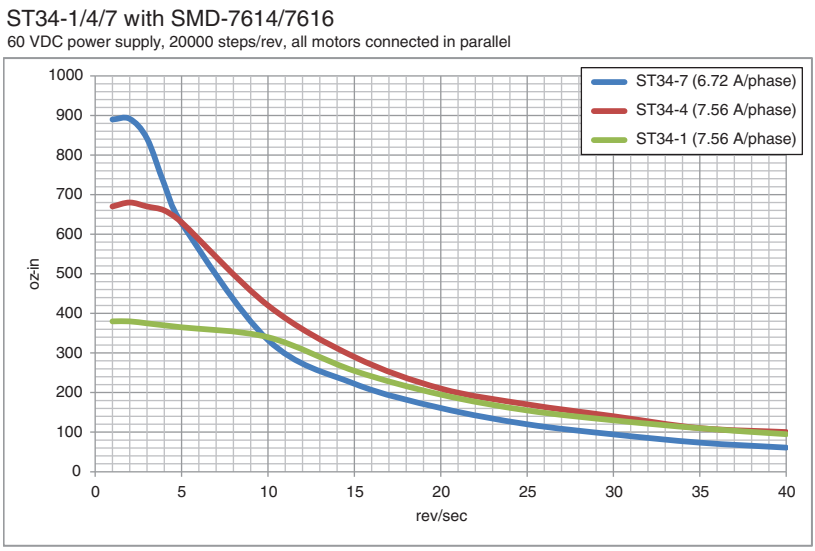


Figure 55. SMD-7614/7616 Torque Curve for ST34-1/4/7, 60V Power Supply



Motor Heating

Step motors convert electrical power from the driver into mechanical power to move a load. Because step motors are not perfectly efficient, some of the electrical power turns into heat on its way through the motor. This heating is not so much dependent on the load being driven but rather the motor speed and power supply voltage. There are certain combinations of speed and voltage at which a motor cannot be continuously operated without damage.

The following table and figures show the maximum duty cycle versus speed for each motor at commonly used power supply voltages. Please refer to this information when planning your application.

A step motor typically reaches maximum temperature after 30 to 45 minutes of operation. If you run the motor for one minute then let it sit idle for one minute, that is a 50% duty cycle. Five minutes on and five minutes off is also 50% duty. However, one hour on and one hour off has the effect of 100% duty because during the first hour the motor will reach full (and possibly excessive) temperature.

The actual temperature of the motor depends on how much heat is conducted, convected, or radiated out of it. Our measurements were made in a 40 °C (104 °F) environment with the motor mounted to an aluminum plate sized to provide a surface area consistent with the motor power dissipation. Your results may vary.

Table 4. SMD-761x Maximum Motor Duty Cycle

Motor	Drive Current (A), peak of sine	Max Duty Cycle at 40 °C	
		24 VDC	48 VDC
ST11-1	1.2	100%	
ST11-2	1.2	100%	
ST14-1	1.2	See chart	
ST17-1	1.6	100%	See chart
ST17-2	2.0	100%	See chart
ST17-3	2.0	100%	See chart
ST23-1	3.4	100%	See chart
ST23-4	5.0	See chart	See chart
ST23-6	5.0	See chart	See chart
ST34-2	10.0	See chart	See chart
ST34-5	9.7	See chart	See chart
ST34-8	10.0	See chart	See chart

Figure 56. Duty Cycle for the ST17-1 with the SMD-761x, 24 VDC

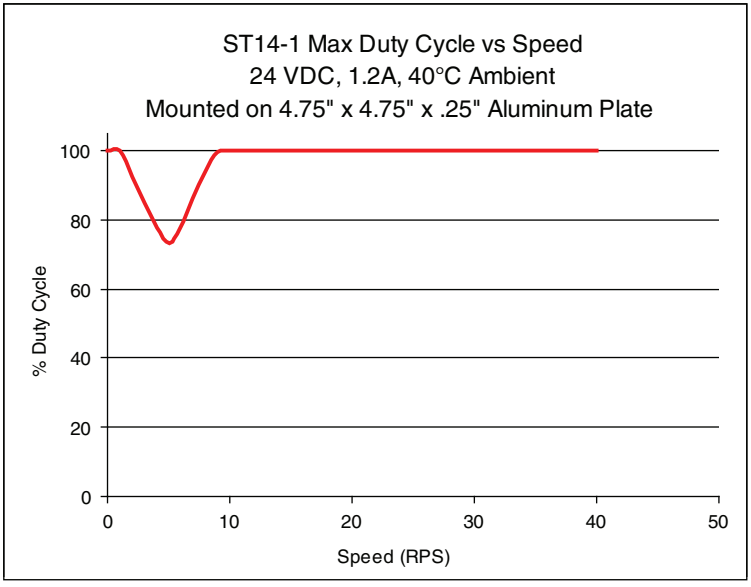


Figure 57. Duty Cycle for the ST17-1 with the SMD-761x, 48 VDC

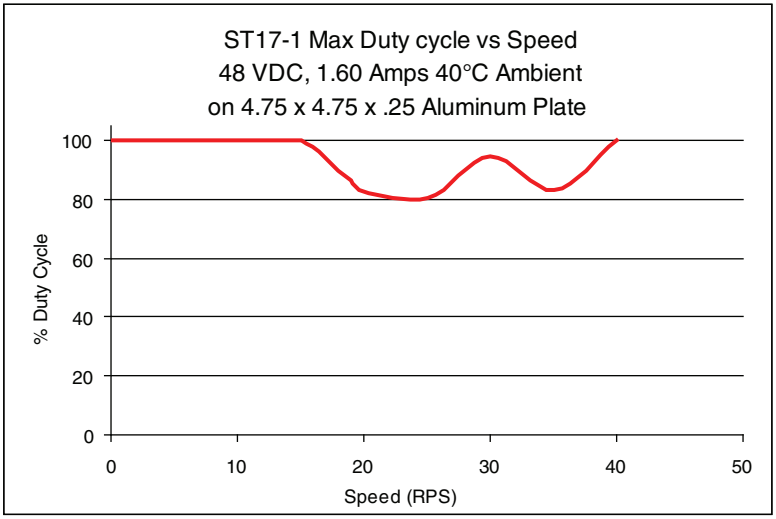


Figure 58. Duty Cycle for the ST17-2 with the SMD-761x, 48 VDC

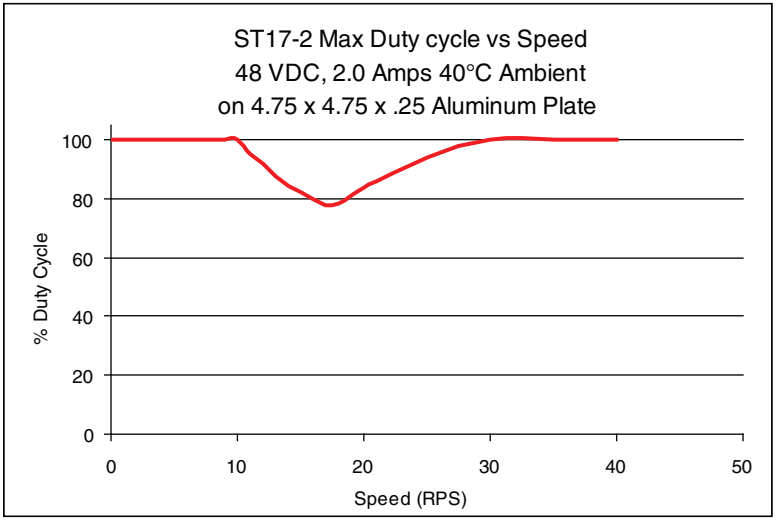


Figure 59. Duty Cycle for the ST17-3 with the SMD-761x, 48 VDC

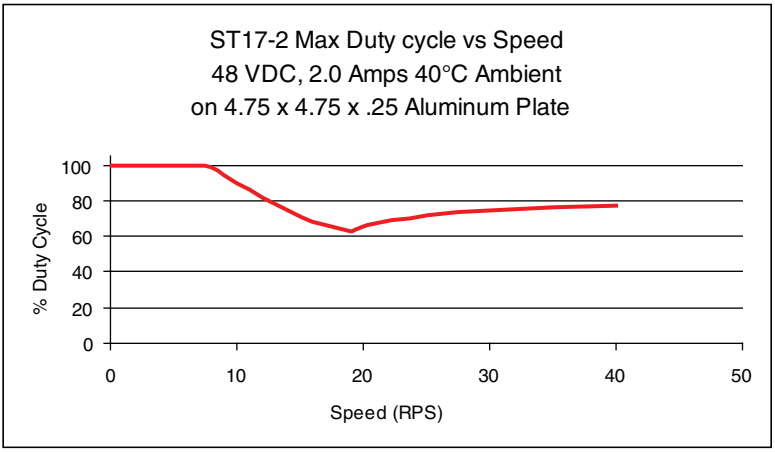


Figure 60. Duty Cycle for the ST23-1 with the SMD-761x, 48 VDC

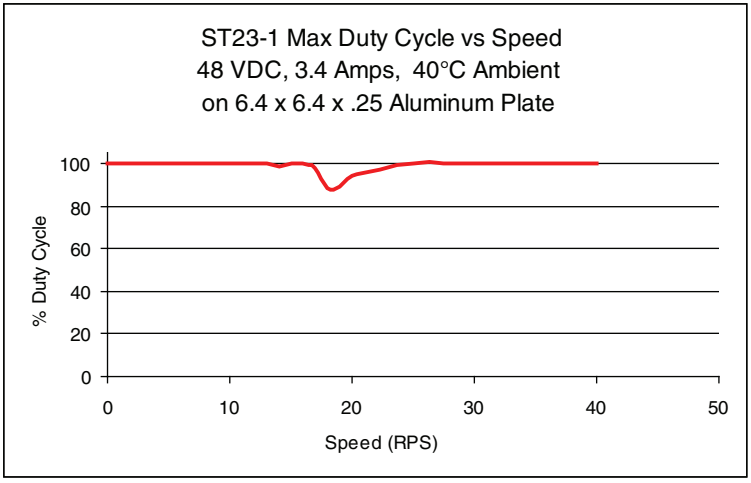


Figure 61. Duty Cycle for the ST23-4 with the SMD-761x, 24 VDC

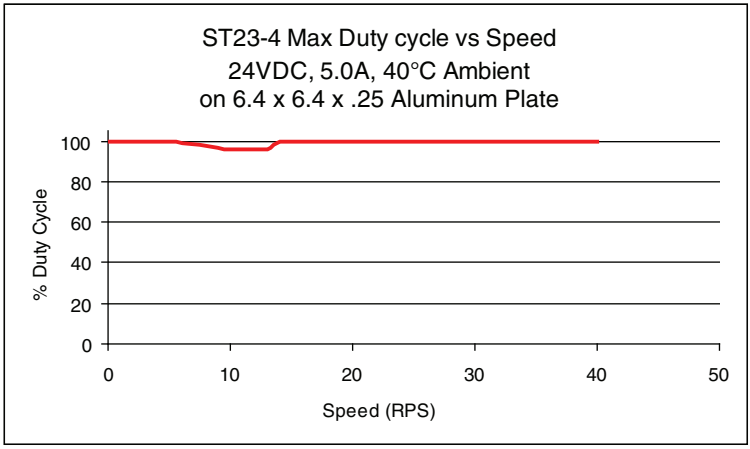


Figure 62. Duty Cycle for the ST23-4 with the SMD-761x, 48 VDC

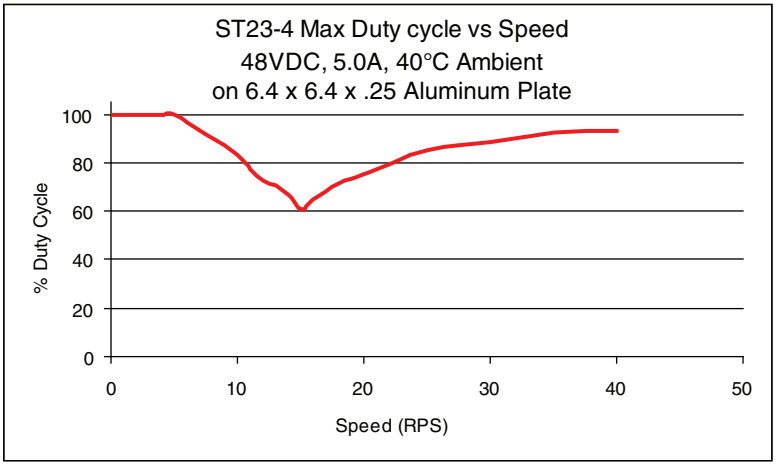


Figure 63. Duty Cycle for the ST23-6 with the SMD-761x, 24 VDC

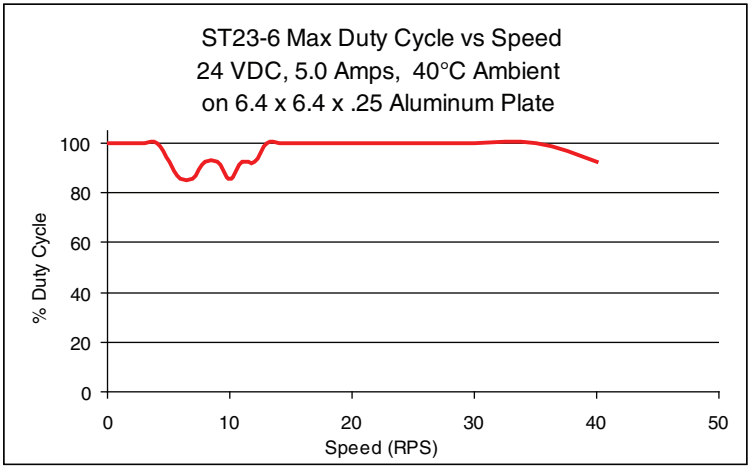


Figure 64. Duty Cycle for the ST23-6 with the SMD-761x, 48 VDC

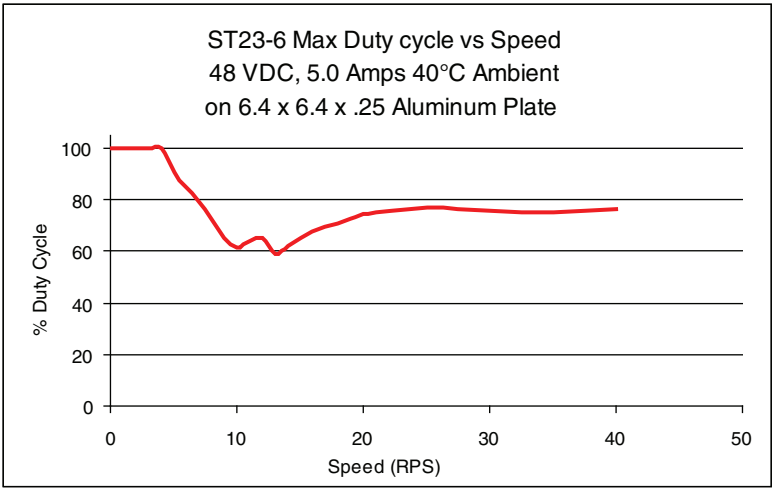


Figure 65. Duty Cycle for the ST34-2 with the SMD-761x, 48 VDC

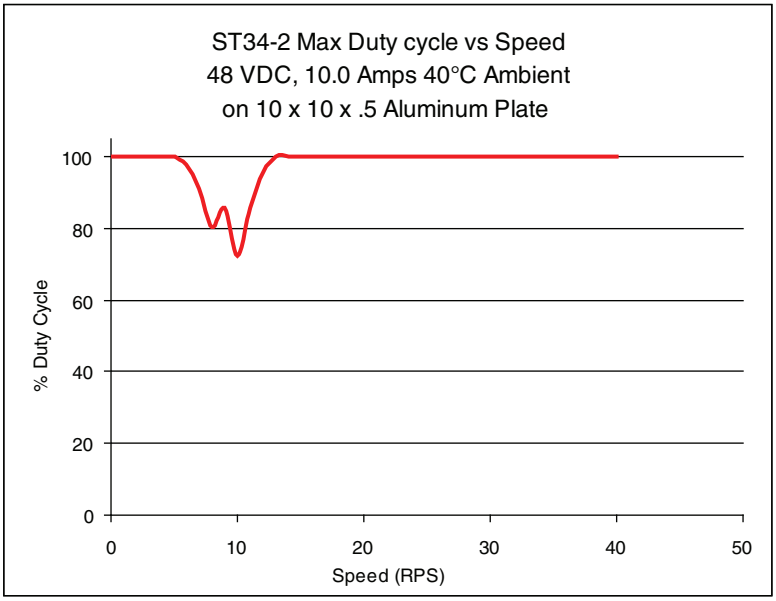


Figure 66. Duty Cycle for the ST34-2 with the SMD-761x, 80 VDC

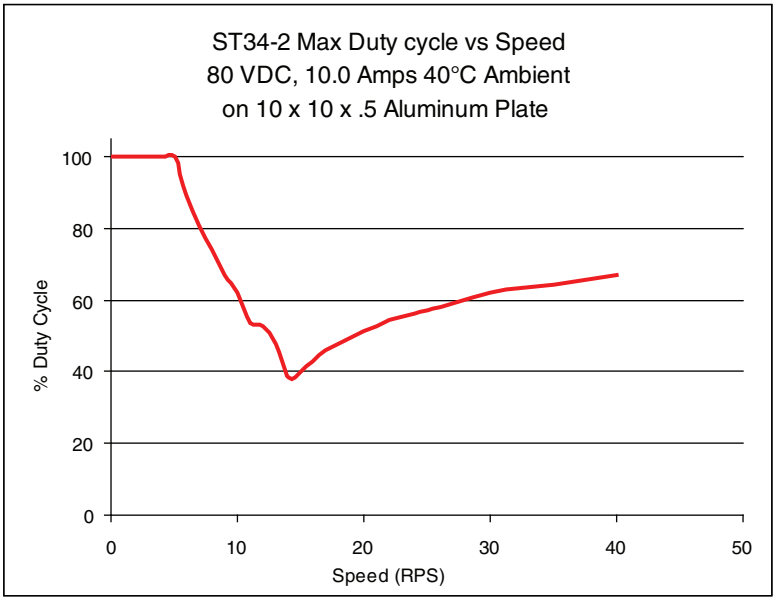


Figure 67. Duty Cycle for the ST34-5 with the SMD-761x, 48 VDC

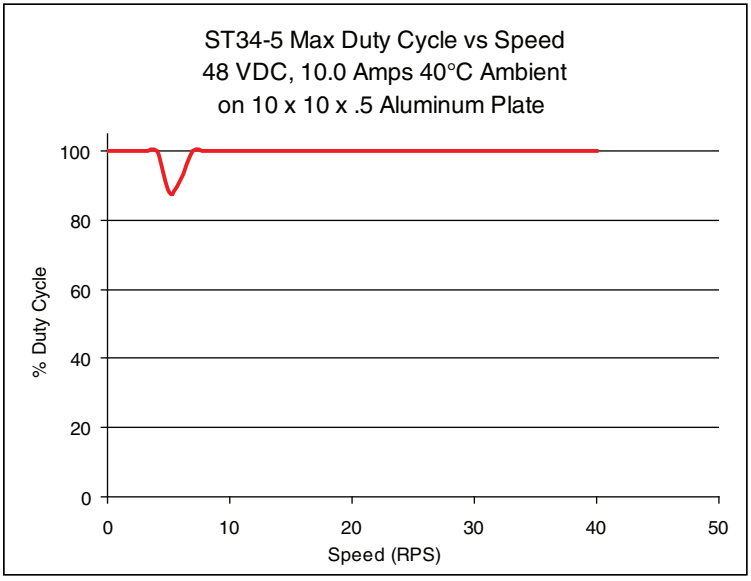


Figure 68. Duty Cycle for the ST34-5 with the SMD-761x, 80 VDC

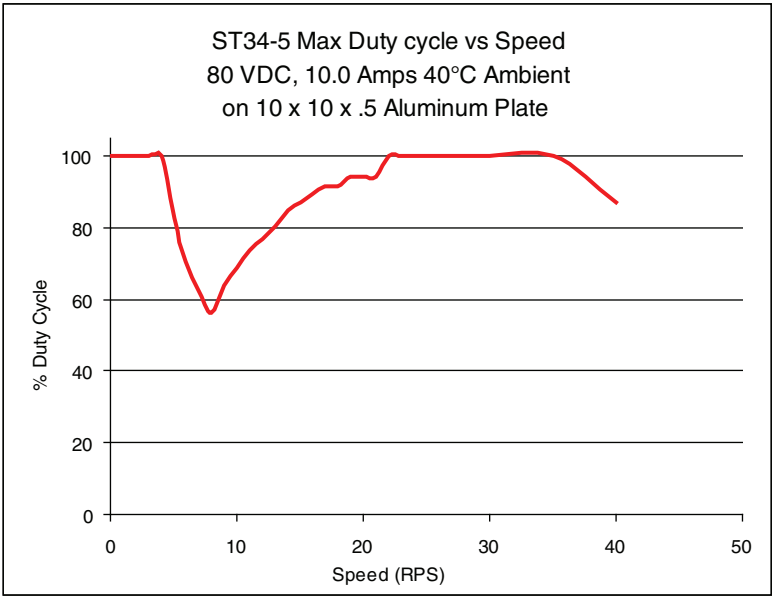


Figure 69. Duty Cycle for the ST34-8 with the SMD-761x, 48 VDC

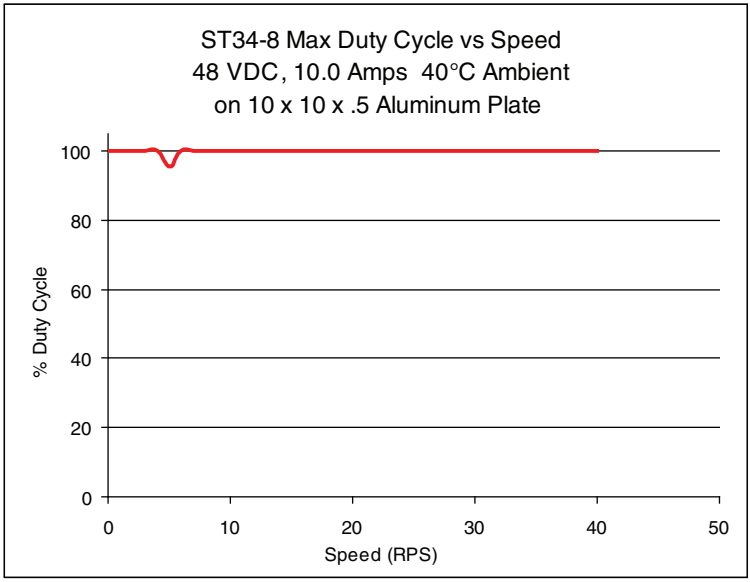
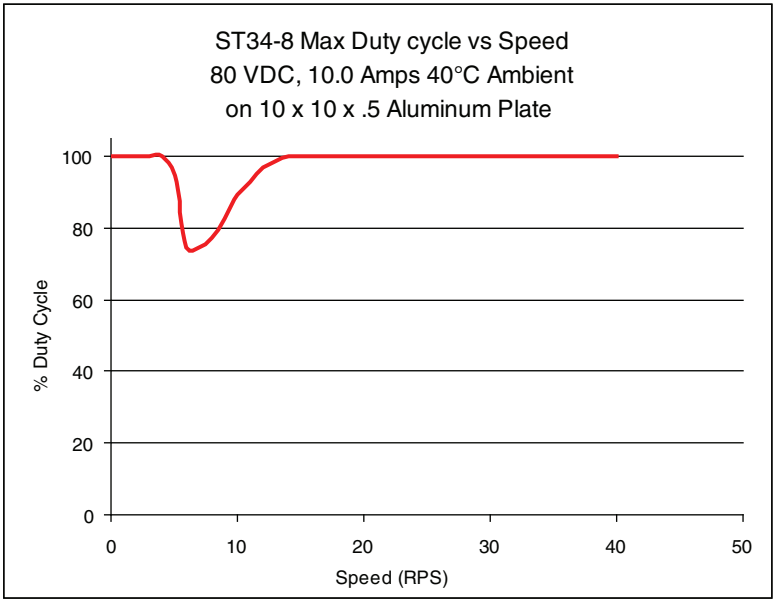


Figure 70. Duty Cycle for the ST34-8 with the SMD-761x, 80 VDC



Drive Heating

While NI SMD-7613/7614/7615/7616 devices efficiently transmit power between the power supply and motor, they do generate some heat in the process. This will cause the temperature of the drive to rise above the surrounding air temperature and may also require that the drive be mounted to a heat conducting metal surface.

To calculate the power dissipation and temperature rise, the following information is provided.

Given:

drive power dissipation P_d versus motor (refer to the figures below)

drive thermal constant R_Q

The final drive case temperature is given by:

$T_C = T_a + R_Q * P_d$

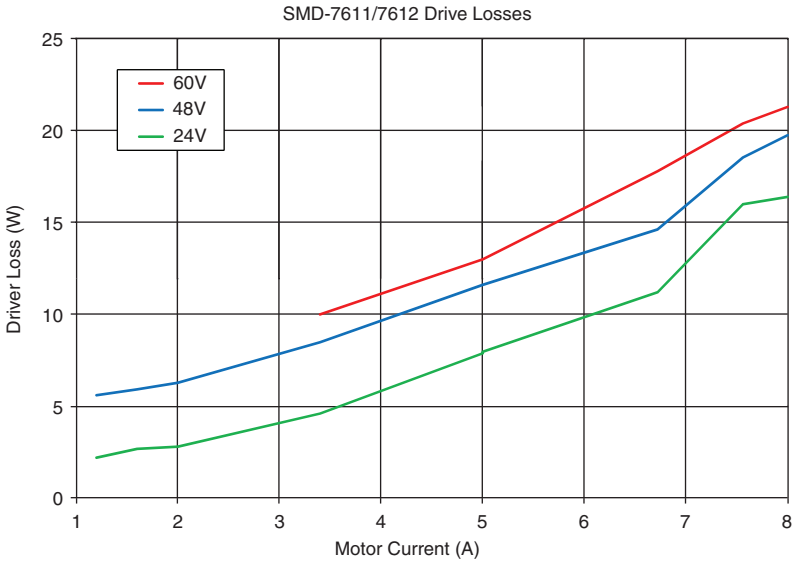
where T_a is the ambient temperature of the surrounding air. The case of the drive should not be allowed to exceed 70 °C or the life of the product could be reduced.

Drive thermal constant:

Narrow side of drive mounted on a 3.5” × 13.5” steel plate, 0.070 in. thick: $R_\theta = 1.0$ °C/W

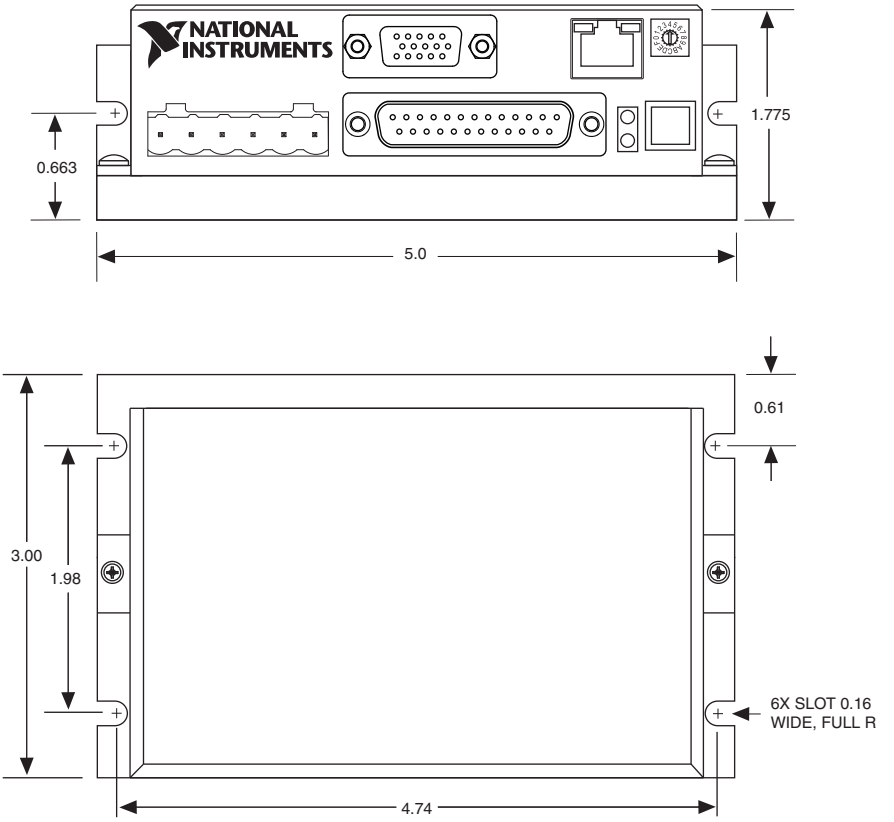
Narrow side of drive mounted on a non-heat conducting surface: $R_\theta = 2.1$ °C/W

Figure 71. Drive Thermal Losses



Mechanical Outline

Figure 72. Mechanical Dimensions



Technical Specifications

Amplifier

Features ..... Digital MOSFET. 20 kHz PWM. Suitable for driving step motors with four, six, or eight leads.

SMD-7613/7615

Supply voltage ..... 12 to 53 VDC

Motor current ..... 0.5 to 5.0 A/phase peak of sine

SMD-7614/7616

Supply voltage ..... 18 to 88 VDC

Motor current ..... 0.5 to 10.0 A/phase peak of sine

Digital inputs

Step & Direction

Isolation ..... Optically isolated, 5 V logic

Digital logic ..... 5 V, differential

Internal resistance ..... 330 Ω

Minimum pulse width..... 0.5 µsec

Minimum set-up, direction ..... 2 0.5 µsec

Other inputs

Isolation ..... Optically isolated, 12 V logic

Digital logic ..... 12 to 24 V, differential

Internal resistance ..... 22000 Ω

Analog inputs

Input voltage ..... ±10 VDC

Internal resistance ..... 100 kΩ

Output ..... Photodarlington, 100 mA, 30 VDC max.

Voltage drop..... 1.2 V max at 100 mA

+5V Output ..... 5 VDC

Max current..... 100 mA

Dimensions ..... 1.775 × 3.0 × 5.0 in. (45 × 76.2 × 127 mm)

Weight..... 10 oz (280 g)

Operating temperature range ..... 0 °C to 40 °C

Mating connectors

Motor/power supply ..... Phoenix Contact 1757051 (included)

IN/OUT1..... DB-25 male (included)

Encoder feedback ..... HD-15 male

Accessories

Regeneration clamp ..... NI SMD-7700, NI part number 748908-01

Alarm Codes

In the event of an error, the green LED on the main board will flash one or two times, followed by a series of red flashes. The pattern repeats until the alarm is cleared.

Table 5. Status LED Blink Code Definitions

Blink sequence	Code	Error
G	Solid green	No alarm, motor disabled
GG (slow)	Flashing green	No alarm, motor enabled
RG	1 red, 1 green	Motor stall (encoder-equipped only)
RGG	1 red, 2 green	Move attempted, drive disabled
RRG	2 red, 1 green	CCW limit
RRGG	2 red, 2 green	CW limit
RRRG	3 red, 1 green	Drive overheating
RRRGG	3 red, 2 green	Internal voltage out of range
RRRRG	4 red, 1 green	Power supply overvoltage
RRRRGG	4 red, 2 green	Power supply underoltage
RRRRRG	5 red, 1 green	Over current /short circuit
RRRRRGG	5 red, 2 green	Motor resistance out of range
RRRRRRG	6 red, 1 green	Open motor winding
RRRRRRGG	6 red, 2 green	Bad encoder signal
RRRRRRRG	7 red, 1 green	Serial communication error
RRRRRRRRG	8 red, 1 green	Internal voltage out of range

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